SPH ENGINEERING INC
Real World Engineering Solutions

1-65 Springbank Avenue North
Woodstock, Ontario N4S 8V8

April 21, 2021

Woodstock Bus Building Expansion

Storm Water Management Brief

1. Background

The City of Woodstock owns the property, approximately 8.76 hectares in size, at 944 James Street in Woodstock for their engineering, bylaw, public works and transit operations. They are proposing an 18.3m addition to the bus building located in the southwest corner of their property, 65 Clarke Street South (the site).

The extent of the site for this storm water management brief is limited to the area of the proposed addition and reworked asphalt and grass areas west of the addition, 0.176 hectares in size. It is assumed that the property's existing storm water management is sufficient and meets the requirements for the City of Woodstock and has not been reviewed in this storm water management brief.

This storm water management design brief has been prepared to address the increase in site runoff from the proposed addition and the proposed future additions.

2. Pre and Post Development Runoff

Predevelopment

The site is currently partially developed and is bounded by a garbage and recycling facility to the north, City of Woodstock storage yard to the east, a CN Rail right of way and Brick Ponds Wetland to the south and Clarke Street to the west. The developed and undeveloped portion of the site overland flows to the southwest corner where it leaves the site via grass ditch between the site and CN Rail right-of-way towards Clarke Street. The predevelopment condition for this site is taken as current conditions with a runoff coefficient of 0.543.

Post Development

The table below summarizes the areas for the predevelopment and the proposed development for the post development conditions. The following table summarizes the site surface areas and their corresponding runoff coefficients for the undeveloped portion of the site, approximately 0.176 hectares.

Runoff Coefficients				
PREDEVELOPMENT	Area (m^2)	%	Runoff Coefficient	C*A
Building/Conc/Asph.	797.03	45.11	0.90	717.33
Recycled Asph.	0.00	0.00	0.85	0.00
Gravel	0.00	0.00	0.60	0.00
Grass/Landscaping	969.85	54.89	0.25	242.46
Total	1766.88	100.00		959.79
			Avg C =	**0.543**
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POST DEVELOPMENT	Area (m^2)	%	Runoff Coefficient	C*A
Building/Conc/Asph.	939.94	53.20	0.90	845.95
Recycled Asph.	0.00	0.00	0.85	0.00
Gravel	0.00	0.00	0.60	0.00
Grass/Landscaping	826.94	46.80	0.25	206.74
Total	1766.88	100.00		1052.68
			Avg C =	**0.596**

3. Storm Water Management

a. Design Criteria

The City of Woodstock stormwater management design criteria for the site is to limit all post development flows to the 5-year predevelopment flow and provide the required storage for post development flows.

b. Site Storm Water Storage and Flow Control

The runoff coefficient for the site has increased from 0.543 for current conditions to 0.596 for the proposed development, thus requiring peak flow control and on-site storage for all storm events.

Using this criteria, a 179mm diameter orifice cap is required at the proposed storm detention pond to reduce the 250 year storm flow to 0.037m^3/s, which is less than the predevelopment 5 year storm.

A new storm detention pond is proposed to store the rainfall runoff for all storm events. The detention pond has a storage capacity of 12.8m^3 which is sufficient to store the runoff for all storm events up to the 250-year storm.

c. Water Quality

Since the storm detention pond outlets into a grass ditch that conveys flows to the Brick Ponds Wetland, water quality needs to be accounted for before leaving the site. A grass swale has been designed in accordance with the Minister of Environment Stormwater Management Planning and Design Manual (MOE SMPDM) to provide water quality enhancement as well as convey flows from the asphalt surface to the storm detention pond.

The grass swale has been designed with the 25mm 4-hour Chicago Storm for quality control and the 2 year to 250 year storm events for conveyance capacities. For the swale to provide water quality control, the maximum flow allowed is 0.15m^3/s and a maximum velocity of 0.5m/s is recommended.

The grass swale has been designed for a peak flow of 0.0095m^3/s and a velocity of 0.335m/s for the 25mm 4-hour Chicago quality control storm (Appendix A). The grass swale has an average slope of 2% to reduce the velocity and promote water treatment. This swale drains into the proposed detention pond where it outlets to a grass ditch that conveys flows to Brick Ponds Wetland. The swale meets the above requirements to provide storm water quality control as outlined by the MOE SMPDM.

The roof runoff will be conveyed to the pond via downspouts that will connect into the riprap at the beginning of the grass swale prior to entering the pond. This runoff is then captured by the detention pond and discharged from the site to meet the 5-year predevelopment flow rate.

4. Recommendations and Conclusions

1. Further development of the site located in the southwest corner of 944 James Street in Woodstock will increase the peak runoff from the site and require the implementation of stormwater management to address the new peak flows.
2. Peak runoff quantity is to be addressed by the use of a 179mm diameter orifice cap the outlet of the storm detention pond, will limit post development peak flows to the 5-year predevelopment.
3. Runoff water quality will be managed by the grass swale that conveys flows from the asphalt and building expansion to the detention pond.
4. The implementation of the stormwater management plan as outlined above will maintain the post development flows at or below defined predevelopment.

Report prepared by

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Appendix A: Design Calculations

1-65 Springbank Avenue North
Woodstock, Ontario N4S 8V8
2021-04-21

Project: 20162 **Bus Shelter Expansion**

Runoff Coefficients

* Pre-Development = Current Conditions

PREDEVELOPMENT	Area (m^2)	%	Runoff Coefficient	C*A
Building/Conc/Asph.	795.20	45.06	0.90	715.68
Recycled Asph.	0.00	0.00	0.85	0.00
Hard Packed Gravel	0.00	0.00	0.85	0.00
Grass/Landscaping	969.60	54.94	0.25	242.40
	1764.80	100.00		958.08
			Avg C =	**0.543**

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POST DEVELOPMENT	Area (m^2)	%	Runoff Coefficient	C*A
Building/Conc/Asph.	959.91	54.39	0.90	863.92
Recycled Asph.	0.00	0.00	0.85	0.00
Hard Packed Gravel	0.00	0.00	0.85	0.00
Grass/Landscaping	804.89	45.61	0.25	201.22
	1764.80	100.00		1065.14
			Avg C =	**0.604**

Area Check = 0.00

Time of Concentration

PREDEVELOPMENT	POST DEVELOPMENT
Bransby Williams Formula	Bransby Williams Formula
For sites with a runoff coefficient greater than 0.4	For sites with a runoff coefficient greater than 0.4
$tc = 0.057L/(Sw^{0.2}A^{0.1})$	$tc = 0.057L/(Sw^{0.2}A^{0.1})$
L = 55 m; W = 32 m	L = 55 m; W = 32 m
Sw = 4 %	Sw = 4 %
A = 0.176 ha	A = 0.176 ha
tc= 2.83 min	tc= 2.83 min

PREDEVELOPMENT		
tc =	2.83	min
C =	0.543	

POST DEVELOPMENT		
tc =	2.83	min
C =	0.604	

Outflow-Storage Summary	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	250 Year
Predevelopment Peak Flow (cms)	0.027	0.037	0.037	0.037	0.037	0.037	0.037
Postdevelopment Peak Flow (cms)	0.030	0.041	0.048	0.056	0.063	0.070	0.070
Maximum Storage Required for Peak Attenuation (m^3)	0.845	1.139	3.262	5.733	7.693	9.640	12.687

Orifice Calculation (for 100 Year Storm Event)			
$Q = 0.6A_{pipe}(2*9.8*h)^{0.5}$			
Q =	0.037	cms	**Ok**
Pipe Dia =	179	mm	
A_{pipe} =	0.025	m^2	
h =	0.3	m	

*sized against 5 year predevelopment flow rates

Runoff Calculations

Lot Area = 0.1765 ha

Woodstock Storms Atmospheric Environment Service Data

Time	Time	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	250 Year
min	hr	mm/hr	mm/hr	mm/hr	mm/hr	mm/hr	mm/hr	mm/hr
5	0.0833	102.03	137.46	161.38	189.22	211.31	233.24	236.15
10	0.1667	74.98	100.13	116.81	137.26	152.88	168.15	196.10
15	0.2500	60.16	80.13	93.29	109.78	122.18	134.22	168.34
30	0.5000	39.09	52.11	60.65	71.58	79.66	87.47	119.65
60	1.0000	24.20	32.48	37.90	44.87	50.01	54.98	77.61
120	2.0000	14.56	19.74	23.16	27.51	30.73	33.86	47.05
360	6.0000	6.32	8.75	10.37	12.38	13.90	15.38	19.66
720	12.0000	3.70	5.20	6.20	7.44	8.37	9.30	11.05
1440	24.0000	2.16	3.08	3.71	4.46	5.03	5.61	6.16

2 Year Storm Runoff Calculations

2 Year Rainfall	2 Year Predevelopment			2 Year Post Development				
	Contributing Area	Flow	Vol	Contributing Area	Flow	Vol	Vol. Limit	Storage
mm	ha	m^3/s	m^3	ha	m^3/s	m^3	m^3	m^3
8.50	0.1765	0.0274	8.146	0.1765	0.0304	9.056	8.21	0.85
12.50	0.1765	0.0201	11.973	0.1765	0.0224	13.311	16.42	0.00
15.04	0.1765	0.0161	14.409	0.1765	0.0179	16.019	24.63	0.00
19.54	0.1765	0.0105	18.726	0.1765	0.0117	20.818	49.27	0.00
24.20	0.1765	0.0065	23.185	0.1765	0.0072	25.776	98.53	0.00
29.12	0.1765	0.0039	27.896	0.1765	0.0043	31.013	197.06	0.00
37.92	0.1765	0.0017	36.328	0.1765	0.0019	40.387	591.19	0.00
44.42	0.1765	0.0010	42.554	0.1765	0.0011	47.310	1182.37	0.00
51.88	0.1765	0.0006	49.707	0.1765	0.0006	55.262	2364.75	0.00

5 Year Strom Runoff Calculations

5 Year Rainfall	5 Year Predevelopment			5 Year Post Development				
	Contributing Area	Flow	Vol	Contributing Area	Flow	Vol	Vol. Limit	Storage
mm	ha	m^3/s	m^3	ha	m^3/s	m^3	m^3	m^3
11.46	0.1765	0.0369	10.975	0.1765	0.0410	12.201	11.06	1.14
16.69	0.1765	0.0269	15.989	0.1765	0.0299	17.775	22.13	0.00
20.03	0.1765	0.0215	19.193	0.1765	0.0239	21.338	33.19	0.00
26.06	0.1765	0.0140	24.965	0.1765	0.0155	27.755	66.38	0.00
32.48	0.1765	0.0087	31.115	0.1765	0.0097	34.592	132.75	0.00
39.49	0.1765	0.0053	37.831	0.1765	0.0059	42.058	265.50	0.00
52.50	0.1765	0.0023	50.300	0.1765	0.0026	55.921	796.51	0.00
62.39	0.1765	0.0014	59.775	0.1765	0.0016	66.454	1593.02	0.00
73.96	0.1765	0.0008	70.863	0.1765	0.0009	78.782	3186.04	0.00

10 Year Storm Runoff Calculations

10 Year Rainfall	10 Year Predevelopment			10 Year Post Development				
	Contributing Area	Flow	Vol	Contributing Area	Flow	Vol	Vol. Limit	Storage
mm	ha	m^3/s	m^3	ha	m^3/s	m^3	m^3	m^3
13.45	0.1765	0.0369	12.884	0.1765	0.0481	14.324	11.06	3.26
19.47	0.1765	0.0269	18.652	0.1765	0.0348	20.737	22.13	0.00
23.32	0.1765	0.0215	22.344	0.1765	0.0278	24.841	33.19	0.00
30.32	0.1765	0.0140	29.052	0.1765	0.0181	32.298	66.38	0.00
37.90	0.1765	0.0087	36.312	0.1765	0.0113	40.370	132.75	0.00
46.31	0.1765	0.0053	44.370	0.1765	0.0069	49.328	265.50	0.00
62.21	0.1765	0.0023	59.602	0.1765	0.0031	66.262	796.51	0.00
74.46	0.1765	0.0014	71.337	0.1765	0.0019	79.308	1593.02	0.00
88.92	0.1765	0.0008	85.197	0.1765	0.0011	94.717	3186.04	0.00

25 Year Storm Runoff Calculations

25 Year Rainfall	25 Year Predevelopment			25 Year Post Development				
	Contributing Area	Flow	Vol	Contributing Area	Flow	Vol	Vol. Limit	Storage
mm	ha	m^3/s	m^3	ha	m^3/s	m^3	m^3	m^3
15.77	0.1765	0.0369	15.107	0.1765	0.0564	16.795	11.06	5.73
22.88	0.1765	0.0269	21.917	0.1765	0.0409	24.367	22.13	2.24
27.45	0.1765	0.0215	26.296	0.1765	0.0327	29.234	33.19	0.00
35.79	0.1765	0.0140	34.288	0.1765	0.0213	38.119	66.38	0.00
44.87	0.1765	0.0087	42.992	0.1765	0.0134	47.796	132.75	0.00
55.01	0.1765	0.0053	52.705	0.1765	0.0082	58.595	265.50	0.00
74.29	0.1765	0.0023	71.180	0.1765	0.0037	79.134	796.51	0.00
89.23	0.1765	0.0014	85.488	0.1765	0.0022	95.041	1593.02	0.00
106.93	0.1765	0.0008	102.451	0.1765	0.0013	113.899	3186.04	0.00

50 Year Storm Runoff Calculations

50 Year Rainfall	50 Year Predevelopment			50 Year Post Development				
	Contributing Area	Flow	Vol	Contributing Area	Flow	Vol	Vol. Limit	Storage
mm	ha	m^3/s	m^3	ha	m^3/s	m^3	m^3	m^3
17.61	0.1765	0.0369	16.871	0.1765	0.0630	18.756	11.06	7.69
25.48	0.1765	0.0269	24.411	0.1765	0.0456	27.139	22.13	5.01
30.54	0.1765	0.0215	29.265	0.1765	0.0364	32.535	33.19	0.00
39.83	0.1765	0.0140	38.160	0.1765	0.0238	42.424	66.38	0.00
50.01	0.1765	0.0087	47.916	0.1765	0.0149	53.270	132.75	0.00
61.46	0.1765	0.0053	58.881	0.1765	0.0092	65.461	265.50	0.00
83.39	0.1765	0.0023	79.897	0.1765	0.0041	88.825	796.51	0.00
100.48	0.1765	0.0014	96.271	0.1765	0.0025	107.029	1593.02	0.00
120.83	0.1765	0.0008	115.762	0.1765	0.0015	128.698	3186.04	0.00

100 Year Storm Runoff Calculations

100 Year Rainfall	100 Year Predevelopment			100 Year Post Development				
	Contributing Area	Flow	Vol	Contributing Area	Flow	Vol	Vol. Limit	Storage
mm	ha	m^3/s	m^3	ha	m^3/s	m^3	m^3	m^3
19.44	0.1765	0.0369	18.621	0.1765	0.0696	20.702	11.06	9.64
28.02	0.1765	0.0269	26.850	0.1765	0.0501	29.850	22.13	7.72
33.56	0.1765	0.0215	32.149	0.1765	0.0400	35.742	33.19	2.55
43.74	0.1765	0.0140	41.903	0.1765	0.0261	46.586	66.38	0.00
54.98	0.1765	0.0087	52.678	0.1765	0.0164	58.565	132.75	0.00
67.72	0.1765	0.0053	64.877	0.1765	0.0101	72.126	265.50	0.00
92.31	0.1765	0.0023	88.440	0.1765	0.0046	98.323	796.51	0.00
111.59	0.1765	0.0014	106.911	0.1765	0.0028	118.857	1593.02	0.00
134.63	0.1765	0.0008	128.988	0.1765	0.0017	143.401	3186.04	0.00

250 Year Storm Runoff Calculations

250 Year Rainfall	250 Year Predevelopment			250 Year Post Development				
	Contributing Area	Flow	Vol	Contributing Area	Flow	Vol	Vol. Limit	Storage
mm	ha	m^3/s	m^3	ha	m^3/s	m^3	m^3	m^3
19.68	0.1765	0.0369	18.854	0.1765	0.0704	20.961	11.06	9.90
32.68	0.1765	0.0269	31.314	0.1765	0.0585	34.813	22.13	12.69
42.09	0.1765	0.0215	40.322	0.1765	0.0502	44.828	33.19	11.64
59.83	0.1765	0.0140	57.319	0.1765	0.0357	63.724	66.38	0.00
77.61	0.1765	0.0087	74.359	0.1765	0.0231	82.668	132.75	0.00
94.11	0.1765	0.0053	90.161	0.1765	0.0140	100.236	265.50	0.00
117.93	0.1765	0.0023	112.988	0.1765	0.0059	125.614	796.51	0.00
132.59	0.1765	0.0014	127.032	0.1765	0.0033	141.228	1593.02	0.00
147.75	0.1765	0.0008	141.561	0.1765	0.0018	157.379	3186.04	0.00

SPH ENGINEERING INC.
REAL WORLD ENGINEERING SOLUTIONS

1-65 Springbank Avenue North
Woodstock, Ontario N4S 8V8
2021-04-21

Project: 20162 Bus Shelter Expansion

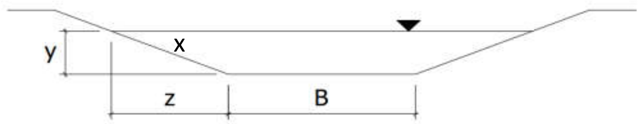
Quality Storm: 25mm 4hr Chicago Storm

C =	0.604		
i =	31.85256375	mm/hr	MOE Eq. 4.9
A =	0.176	ha	
Q =	0.0095	m^3/s	MOE Eq. 4.8
Q_{max} =	0.15	m^3/s	Max flow to provide water quality
V_{max} =	0.50	m/s	Max velocity to provide water quality

Typical Manning's n Values
0.035 - Grassed Lined
0.013 - Smooth Concrete
0.022 - No Vegetation
0.025 - Rip Rap

Swale Geometry

n =	0.035		
S =	0.02	m/m	Channel Slope
B =	1	m	Bottom Width
θ =	3	: 1	Side Slope (H:V)
d =	0.5	m	Design Depth



Water Quality Check			
Q =	0.0095	m^3/s	Max Design Flow
Q =	0.0093	m^3/s	Flow Capacity
y =	0.026	m	Depth for actual flow
z =	0.077	m	
x =	0.081	m	
P_w =	1.163	m	Wetted Perimeter
A =	0.028	m^2	Area
R =	0.024	m	Hydraulic Radius
V =	0.335	m/s	Ok

Q = ### m^3/s = Run Goal Seek to solve Q by changing y

Convayance Capacity

5 Year Strom - Minor Flow				250 Year Storm - Major Flow			
Q_{5year} =	0.041	m^3/s	Max Design Flow	$Q_{100year}$ =	0.070	m^3/s	Max Design Flow
Q =	0.041	m^3/s	Flow Capacity	Q =	0.070	m^3/s	Flow Capacity
y =	0.061	m	Depth for actual flow	y =	0.083	m	Depth for actual flow
z =	0.184	m		z =	0.249	m	
x =	0.194	m		x =	0.263	m	
P_w =	1.388	m	Wetted Perimeter	P_w =	1.526	m	Wetted Perimeter
A =	0.073	m^2	Area	A =	0.104	m^2	Area
R =	0.052	m	Hydraulic Radius	R =	0.068	m	Hydraulic Radius
V =	0.566	m/s		V =	0.674	m/s	

Design Summary		
Bottom Width =	1	m
Side Slopes (H:V)	3	:1
Min. Depth =	0.083	m
Max Depth =	0.5	m
Channel Slope =	2	%
Channel Lining =	Grassed Lined	
Water Quality Provided	**Yes**	
V_{max} =	0.335	m/s
Q_{max} =	0.009	m^3/s